

HOW POST-COVID GLOBAL SUPPLY CHAIN BENEFITTED INDIAN DEFENSE ELECTRONIC INDUSTRY

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ABSTRACT

This work investigates the post-COVID disruption of global supply chains and its effects on the Défense electronics industry of India, particularly as India embarks on a path of self-reliance and resilience. The research shows how COVID exposed the vulnerability linked to foreign imports, leading to enhance the past measures such as "Make in India" and "Atmanirbhar Bharat" by the Indian government to improve local production and decrease dependency on imports. The study identifies important changes in technology and manufacturing capabilities through qualitative analyses of policy actions and international partnerships. It finally makes predictions about a bright future for the Défense electronics sector of India, with the strategic positioning of this sector in the global market, while justifying continuous investment in domestic capabilities and technological innovation.

Keywords: Supply chains, Make in India, Atmanirbhar Bharat, Technological innovation, Défense electronics.

1. Introduction

1.1 Background

1.1.1 Impact of COVID-19 on Global Supply Chains

The COVID-19 pandemic, in particular, exposed the vulnerability of world supply chains when disruptions occurred to logistics, manufacturing, and procurement of raw materials (Orlando *et al.* 2022). Nations dependent on imports for critical industries, including defence, medicine and raw material supply shortages and delays. This disruption hastened the pressing need for localized production and self-sufficiency in strategic sectors.

1.1.2 Shift Towards Supply Chain Resilience

Nations have started diversifying suppliers, which includes near-source production and the enhanced use of digital technologies in the supply chain, due in part to the global tendency after the pandemic to reinforce supply chains (Greenland *et al.* 2023). India has taken advantage of such a trend whilst pursuing its aim of developing an Indigenous Défense electronics industry and of reducing dependence on foreign defence imports.

1.1.3 Opportunities for India's Defense Electronics Sector

Economic conditions were quite difficult for international arms suppliers, so India intensified its efforts under initiatives like "Make in India" and "Atmanirbhar Bharat" (Bhalla *et al.* 2024). The Indian government provided not only incentives but also policy reforms that

facilitated and supported foreign collaborations for increasing the manufacturing levels of domestic producers and cultivating different capabilities in areas from radar to communication devices to electronic warfare. Thus, the post-COVID global supply chain realignment forecasted a very bright future for India's defence electronics industry to grow and strengthen its foothold in the international market.

1.2 Research Aim and Objectives

1.2.1 Research Aim

The aim of the study is to analyse the post-COVID global supply chain changes as related to the capabilities of India's defence electronics industry for improving domestic production, resilience, and technology development.

1.2.2 Research Objectives

- To recognized the impact of post-COVID global supply chain disruptions on the defence electronics sector in India.
- To explore policy interventions and initiatives that have strengthened defence electronics manufacturing capabilities in India.
- To study the role of global collaboration and technology in enhancing the resilience of India's defence supply chain.

1.4 Research Methodology

This is a qualitative research approach, interpretivist philosophy view, and secondary data collection methods to capture global supply chain disruption post-COVID in the Indian defence electronics industry (Chowdhury & Kibria, 2021). The sources of data include government reports, industry publications, policy documents, and academic studies. This will provide insight into how initiatives like 'Make in India' and 'Atmanirbhar Bharat' bolster domestic production and resilience in supply chains. Trends in globalization, technology, and investment will be tied to a clear analysis of stakeholder roles and changing strategies, drawing comparisons between pre and post-pandemic conditions.

2. Literature Review

2.1 Theories and Models.

2.1.1 Global Supply Chain Theory

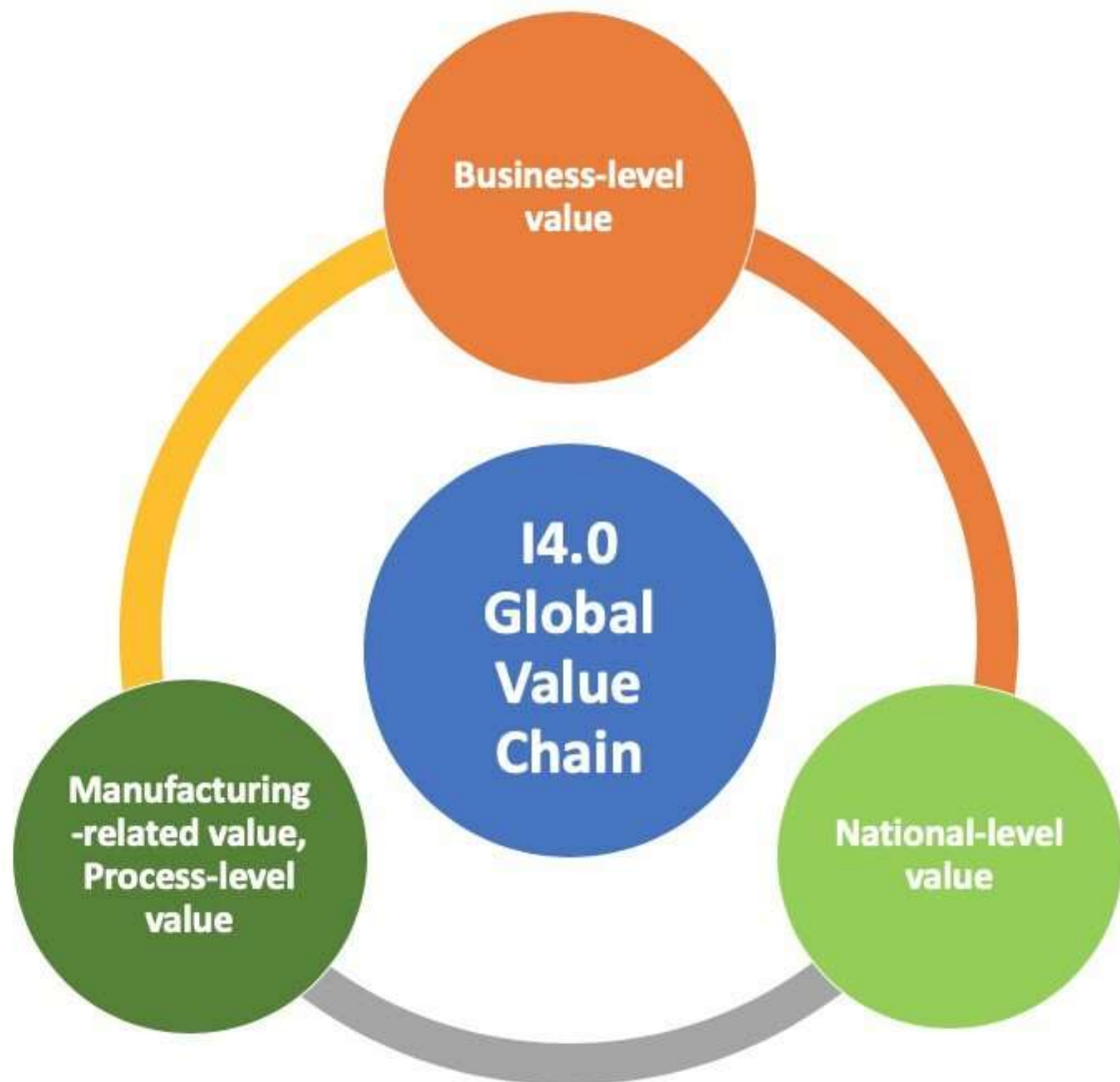


Figure 1: Global Supply Chain Theory

(Source: Precicon, 2022)

This theory centres on the international flow of goods, services, and information. It discusses supply chain resilience and risk management, as well as the strategic vendor choice (Um & Han, 2021). As the pandemic disrupted global supply chains, industries such as defence electronics were forced to critically analyze their sourcing strategies, increase their focus on localization, and devise alternative supply routes. The theory gives credence to how India's defence industry managed disruptions through bolstered domestic production capabilities and reduced dependence on imports.

2.1.2 Resource-Based View (RBV) Theory

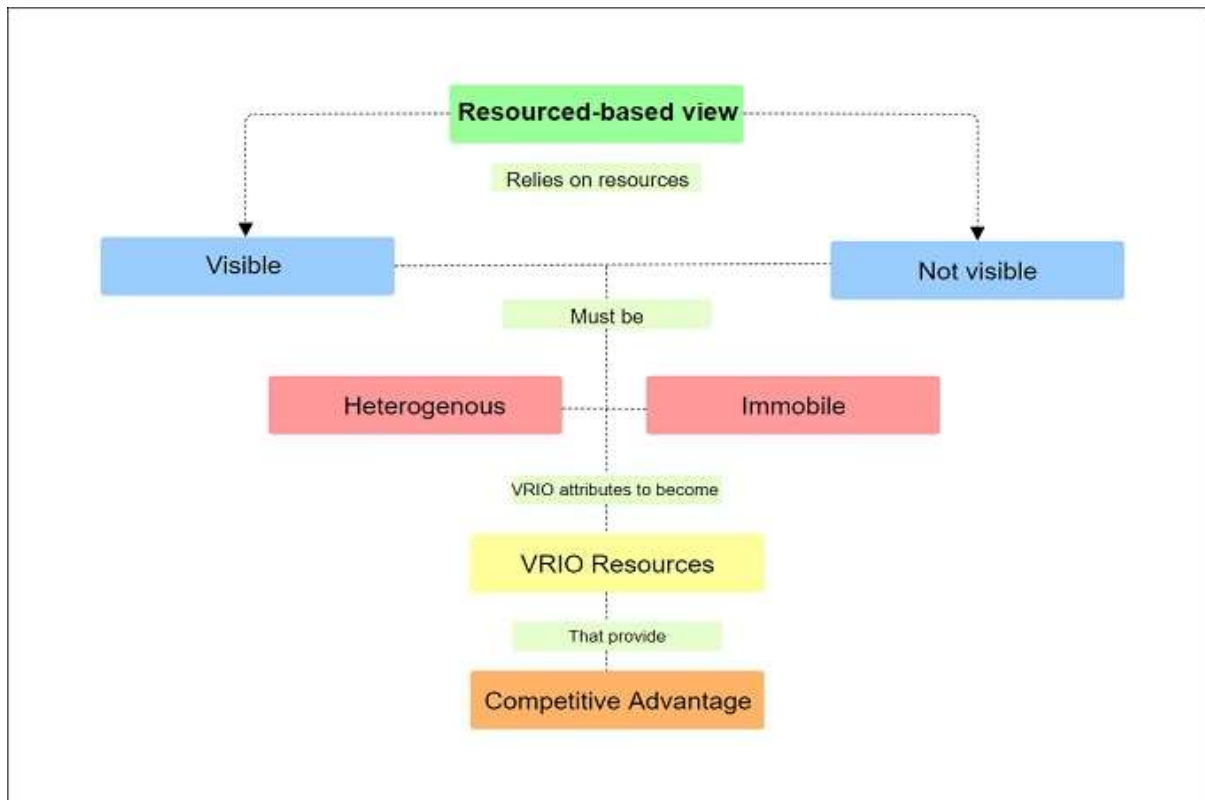


Figure 2: Resource-Based View (RBV) Theory

(Source: Opinaldo, 2022)

According to the RBV theory, a firm's internal resources are the paramount determinants of competitive advantage. It proposes that business enterprises or industries should exploit those resources which are unique, valuable, and inimitable resources to attain a competitive advantage (Madhani, 2021). The post-COVID-19 scenario, with Indian defence electronics relying more on Indigenous technological development, highly skilled human capital, and investments backed by the government, is expected to promote a self-sustaining ecosystem.

2.2 Supply Chain Disruptions on Defense Electronics

With the onset of the COVID-19 pandemic, the weaknesses of India in reliance on the import of components for defense electronics were critically exposed. The disruptions of the global supply chain implied delays in procurement, increased costs, and denial of access to critical technologies (Aldabous, 2024). As a result, the government took the opportunity to reinforce its policy for self-reliance by intervening with policy changes and investments in local manufacturing. The move avoids foreign dependency while providing local firms with the opportunity to optimize their capabilities in the manufacturing of defence electronics components, especially in radar systems, communication devices, and avionics.

2.3 Role of Government Policies

Various policies were brought in by the Indian government to encourage the domestic manufacturing of defence electronics in the wake of COVID. The “Defense Acquisition Procedure (DAP)” 2020 mandated indigenous procurement, while “Production Linked Incentives (PLI)” gave financial assistance to manufacturers (Narang, 2022). The “Strategic Partnership Model” encouraged the private sector to take part in defence production. These initiatives, along with “Make in India” and “Atmanirbhar Bharat”, made an even stronger and more competitive defence electronics industry. Thus, India now has reduced import dependency, grown local production capabilities, and grown into an emerging defence electronics hub.

2.4 Influence of Global Collaborations and Technological Advancements

India has now intensified its global defence partnerships and by post-COVID strategies, could be expected to enhance supply chain resilience (Ocicka *et al.* 2022). Agreements have been made with nations like the U.S., France, and Israel towards the advancement of technology transfer, joint ventures, and investment in research and development. Advancements in Industry 4.0, which include AI, IoT, and automation, have improved manufacturing efficiencies as well as reduced supply chain risks. These partnerships together with innovations are helping in the modernization of India's defense electronics sector to make it self-sufficient and competitive in the global market.

3. Examining the impact of post-COVID global supply chain disruptions on India's defence electronics sector.

The defence electronics sector of India has been severely impacted as a consequence of the global supply chain crisis arising from the COVID-19 pandemic. India always depended on imports for critical defence components. Before the pandemic, around 75% of the country's defence electronics traced their origins to foreign suppliers (Captan, 2023). The disruption of global trade, semiconductor unavailability, and the longer logistics annoyed the vulnerabilities within the Indian defence procurement system. However, the crisis also raised strategic policy investment in domestic manufacturing and more global collaborations. This section explores these impacts under the key sections of vulnerabilities in supply chains, government response to the current crisis, and advancements in technology.

3.1 Supply Chain Disruptions and Their Impact on India's Defense Electronics

India's heavy dependence on imported semiconductors, sensors, avionics, and communication modules became clear during the post-COVID period. Owing to semiconductor shortages between 2020 and 2021, the delivery of critical defence equipment, such as the Tejas fighter jets and the modernization of air defence systems, suffered delays of 6-12 months. For example, not only did supply chain bottlenecks threaten the production of Tejas fighter jets, but they also affected the fielding of modernized air defence systems (Aamir, 2021). Delays in procurement meant that the production of radar systems, electronic warfare tools, and missile guidance systems was also affected. In addition to these challenges, logistical constraints congestion and shipping delays added procurement costs by up to 20%, thus adding much pressure on defense budgets.

3.2 Government Initiatives to Strengthen Domestic Manufacturing

In line with these efforts, the Indian government has announced these initiatives to address import-induced challenges and boost domestic defence electronics production in India through the Production Linked Incentive (PLI) (Mallik, 2023). This scheme is intended to stimulate the manufacturing of electronics in the country and has given a significant contribution of 12% to the increase in the domestic production of components related to defence electronics in 2021-22. As per Defense Acquisition Procedure (DAP) 2020; 50% of major defense acquisition electronics are required to be procured from Indian manufacturers. The policy promotes self-reliance. Semiconductor Mission (2021) with an investment plan of ₹76,000 crore (\$10 billion) was launched to develop India's semiconductor ecosystem (Holla, 2022). An important focus area of this Mission is dependence on foreign microchips. As a result, companies such as Bharat Electronics Limited (BEL) and Hindustan Aeronautics Limited (HAL) have seen a marked increase in their domestic production levels, and BEL recorded a 20% increase in indigenously manufactured electronic warfare and radar systems in 2022 (Behera, 2023).

4. To explore policy measures and initiatives that have strengthened India's defence electronics manufacturing capabilities.

India's defence electronics segment is strategically gearing itself towards self-sufficiency, especially in this post-COVID scenario (PARACHINI *et al.* 2023). Many policy measures and government initiatives have been undertaken to strengthen domestic manufacturing, lessen dependence on foreign suppliers, and develop technical capabilities. The three most significant ones are the Make in India and Atmanirbhar Bharat initiatives, the Production Linked Incentive (PLI) scheme, and the investments made towards semiconductor and defence technology parks. These collectively reflect substantial progress in the sector in terms of production capacity and export potential. India's defence electronics sector has slipped into an intentional push toward self-reliance, especially in post-COVID times. Many of the policy measures adopted have been framed towards strengthening domestic manufacturing, reducing reliance on foreign suppliers, and improving technological capabilities within the country (Friedberg, 2022). All these create notable advancements in that sector, greatly enhancing both production capacity and export potential.

4.1 Make in India and Atmanirbhar Bharat: Driving Indigenous Production

Launched in 2014, the Make in India scheme and Atmanirbhar Bharat program launched in 2020 has become a key factor in changing the face of defence manufacturing in India (Tripathy & Dastrala, 2023). These initiatives have favoured domestic procurement so that a large portion of the defence budget has been set aside for purchases from Indian manufacturers. For 2021-22, the Government earmarked ₹84,598 crores (\$10.5 billion) for Indigenous defence procurement, an increase from ₹70,221 crores (\$8.7 billion) in the previous year (Ministry of Defence, 2022).

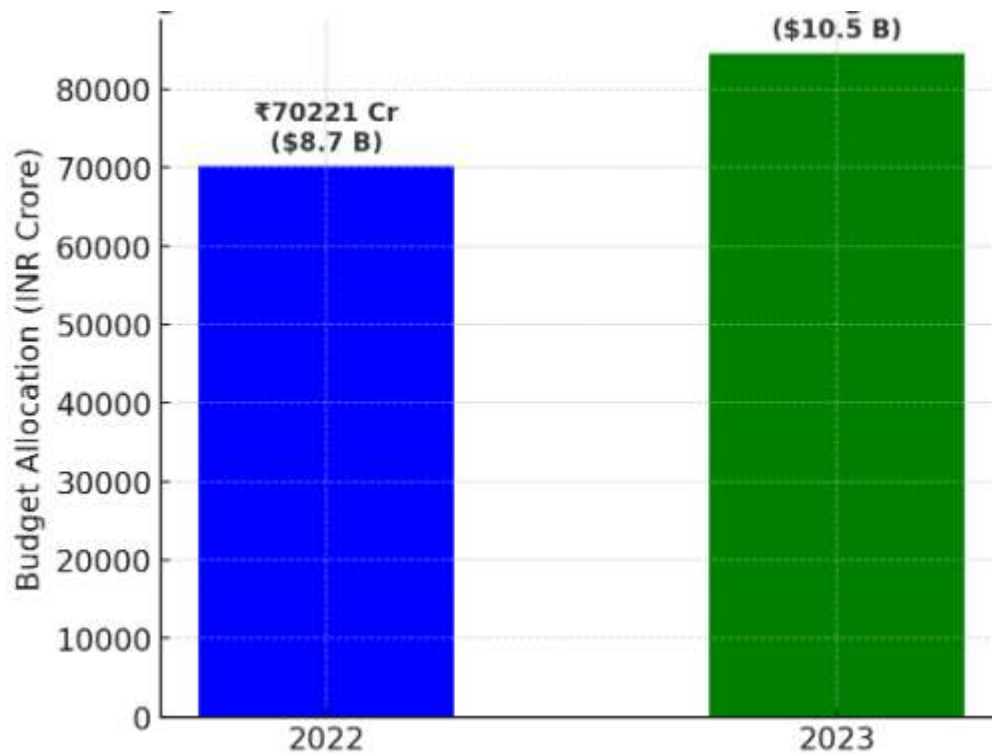


Figure 3: Indigenous defence procurement budget of India

(Source: Self-Made)

The "Ministry of Defense (MoD)" has complemented this shift with a negative import list that imposes restrictions on the import of more than 460 defence-related items such that they must be sourced within the country.

4.2 Production Linked Incentive (PLI) Scheme and the Growth of MSMEs

The launch of the "Production Linked Incentive (PLI)" scheme in 2020 has been seen to skyrocket the promise of the Indian defence electronics industry (Deodhar, 2021). Such a scheme incorporates monetary incentives for those ventures focusing on producing critical defence components whose examples include semiconductors, radar systems, and deeper electronic warfare equipment. For the entirety of 2022, the government allocated ₹1,500 crores (\$180 million) to bolster defence electronics manufacturers so that all the important players have the needed support to expand operations (Ezell, 2024).

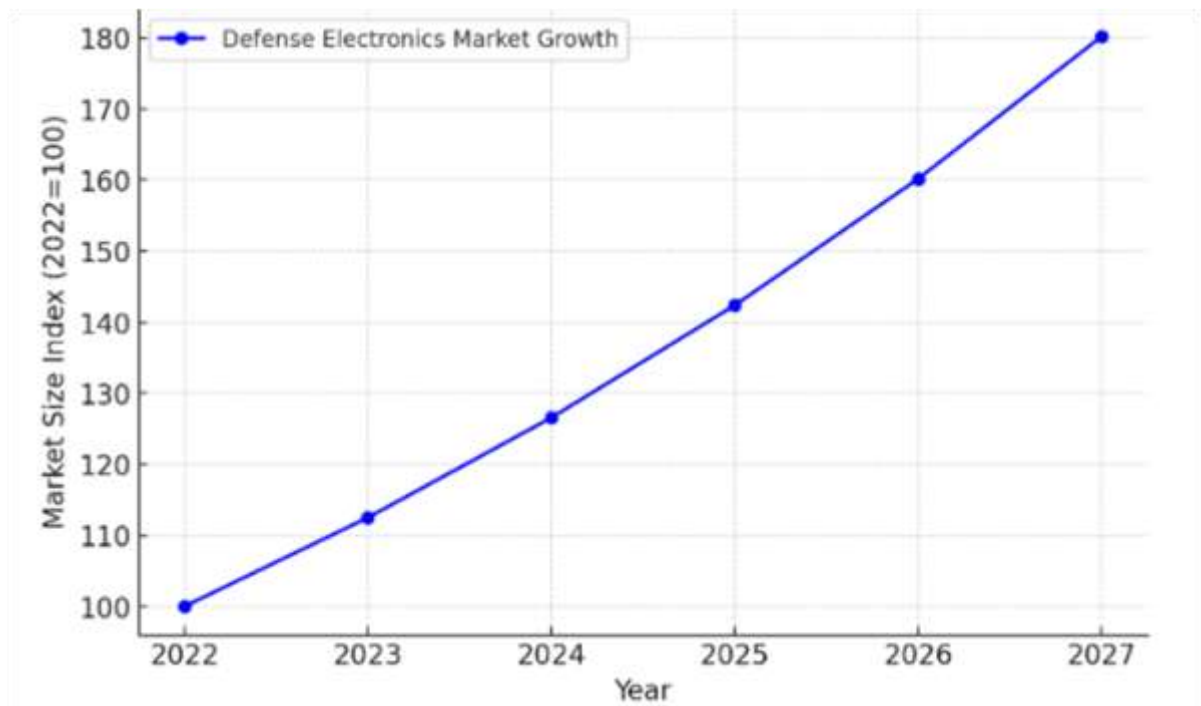


Figure 4: Projected growth rate of the Indian Defense Electronics Market

(Source: Created based on the data from (Marketsandmarkets, (2024); JOSE, 2022))

Indeed, due to the PLI scheme, the market for defence electronics is expected to grow at a "compound annual growth rate (CAGR)" of 12.5% from 2022 to 2027 in India (Marketsandmarkets, (2024); JOSE, 2022). This has further opened up the possibilities for more than 40 new entrants in the form of Micro, Small, and Medium Enterprises (MSMEs) that have stepped into this field, strengthening the domestic supply chain and fuelling intra-manufacturer competition. This has also attracted some of the big names in global defence, such as Lockheed Martin, and Boeing, which have signed joint ventures with Indian firms to manufacture high-end defence electronics in the country. PLI has indeed been successful in developing a competitively productive environment wherein India will build a defence technology developing future export market from an importer.

4.3 Investments in Semiconductor and Defense Technology Parks

Semiconductors are one of the most essential components of electronic defence. They provide power to advanced military systems, radar technologies, and communication devices. To create an ecosystem for domestic chip manufacturing capabilities, the Indian government launched the "India Semiconductor Mission (ISM)" in 2021, bringing in an investment of ₹76,000 crore (\$10 billion) (Indiatvnews, 2025). The significant step, Vedanta-Foxconn, has announced an investment of \$19.5 billion in the country, setting up India's first semiconductor fabrication facility in Gujarat. This is a major step toward reducing dependence on imports of chips.

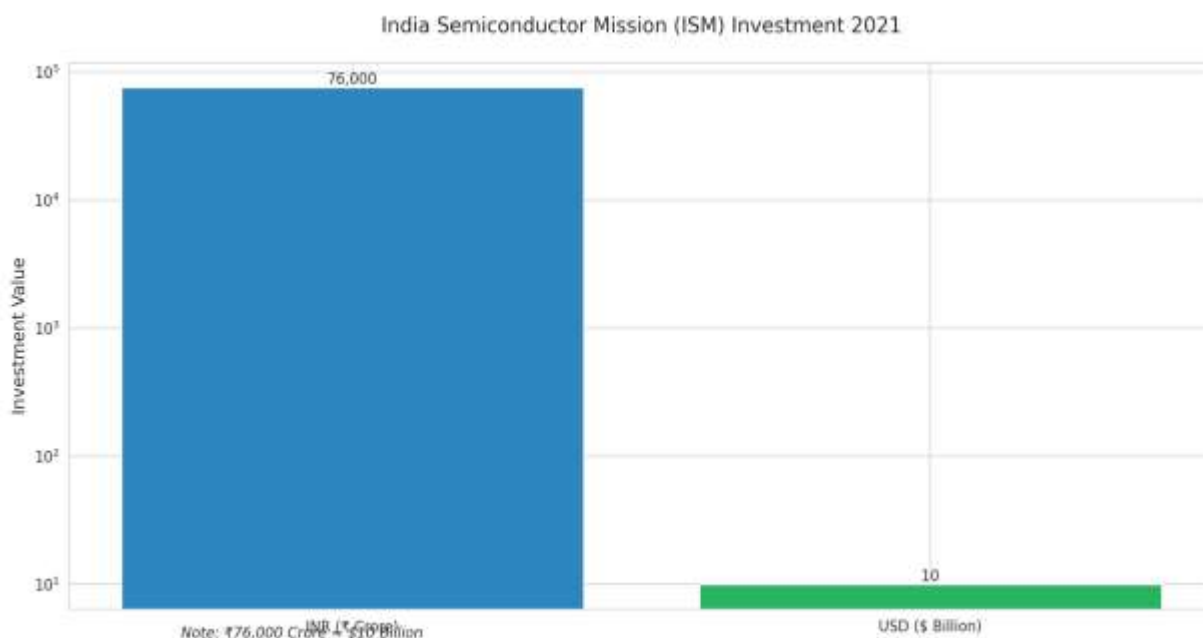


Figure 5: “India Semiconductor Mission (ISM)”

(Source: Created based on Indiatvnews)

Further, Defense Technology Parks have been established for the research, development, and production of superior defence electronics. Investments of ₹11,000 crore (\$1.3 billion) have been mobilized by the Tamil Nadu Defense Industrial Corridor (TNDIC) by 2022, which is expected to foster innovation in avionics, missile guidance systems, and communication technologies (Financialexpress, 2024). The Uttar Pradesh Defense Industrial Corridor (UPDIC) also plays a significant role in supply chain networking and enhances indigenous manufacturing capacities.

5. The Role of Global Collaboration and Technological Advancements in Strengthening India's Defense Supply Chain Resilience

The defence supply chain in India has drastically changed in the post-COVID scenario, mainly due to rampant global collaborations and fast-paced technological advancements. Disruptions caused by the pandemic revealed the weak points inherent in supply networks, leading India to intensify efforts to develop indigenous capabilities and take advantage of global partnerships (Sheehy & Rofiah, 2021). The major constituents of this resilience include international defence collaborations, advancements in indigenous technology, and strategic investments in evolving defence technologies. All these factors may contribute to enhancing India's capability to manufacture critical defence electronics, thereby reducing its import dependence and promoting self-reliance in high-tech defence systems.

5.1 International Defense Collaborations and Joint Ventures

Global partnerships have greatly expedited India's defence supply chain by enabling knowledge transfer, technology sharing, and joint production initiatives. The countries with which India has established strategic defence partnerships to co-develop and manufacture advanced defence systems are the United States, France, Israel, and Russia (Rajiv, 2022). Take,

for instance, the case of India's "Bharat Electronics Limited (BEL)" and France Thales , which have reportedly fortified India's radar and electronic warfare capabilities. Another instance is India's cooperation with Russia on the BrahMos missile program, which has produced significant advances in supersonic missile technology, now domesticating the production of 70% of missile components. The co-development of high-tech military equipment, such as unmanned aerial vehicles (UAVs) and communication systems, will also be taken forward through the "Indo-U.S. Defense Technology and Trade Initiative (DTTI)" (Parpiani, 2024). At the same time, the signing of the "Basic Exchange and Cooperation Agreement (BECA)," which was signed in 2020, will allow India to avail itself of real-time geospatial intelligence from the US, therefore enhancing their defence preparedness. Consequently, from almost zero in 2008, defence trade between India and the United States is now poised at over \$20 billion in 2023.

5.2 Advancements in Indigenous Defense Technology

India has been progressing in many ways in developing indigenous technology to minimize dependence on foreign suppliers. The "Defence Research and Development Organisation (DRDO)" was the frontliner for all these innovations within the fields of radar systems, electronic warfare, and missile guidance technology (Das, 2024). DRDO has successfully developed the "Uttam Active Electronically Scanned Array (AESA)" radar, highlighting India's self-reliance in defence electronics. The AESA radar would be integrated into the Tejas fighter jets and would stop dependence on Israeli and Russian radar systems. India has begun experimenting with self-sufficiency in semiconductor capabilities, which are vital to State-of-the-art defence electronics (Holla, 2022). The shortage projected by many to have a global semiconductor chip deficiency would affect military production across the world. Therefore, India's investments in semiconductor fabrication schemes under the Indian Semiconductor Mission (ISM) are intended to ensure assured supplies for defence applications. By 2029, India's semiconductor industry is slated to reach \$82.96 billion in value," and the risk of vulnerability from global supply chain disruptions will be greatly reduced (Mordorintelligence, 2024).

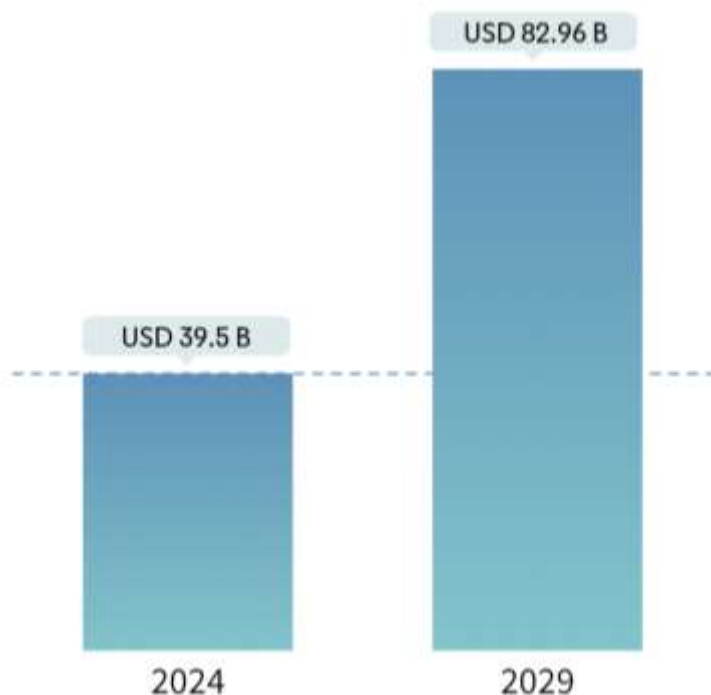


Figure 6: India-semiconductor-market

(Source: Mordorintelligence, 2024)

5.3 Strategic Investments in Emerging Defense Technologies

India is going apace with modernization through intelligent technology in defence supplies. Artificial intelligence (AI), blockchain, and 3D printing are being integrated into defence manufacturing to improve efficiency as well as traceability and speed of production (Hossain, 2023). These predictions will, through intelligent analytics, enhance logistics management and eliminate supply chain bottlenecks, resulting in the timely availability of critical resources for defence. One such important area for investment is 3-D printing technology, which has been utilized to manufacture complex aircraft components at reduced production time and cost. "Hindustan Aeronautics Limited (HAL)" and "Bharat Electronics Limited (BEL)" has efficiently employed 3D printing both for prototyping and producing spare parts for defence which also reduces dependence on conventional modes of manufacture.

6. Future Outlook and Recommendations

6.1 Future Outlook

India's defence electronics industry is on the verge of transformation owing to investments in Indigenous manufacturing, international collaboration, and technological advances. The government's focus on achieving self-reliance through programs such as Atmanirbhar Bharat and boosting semiconductor manufacturing activities will add to the supply chain. With growing geopolitical challenges, India is likely to step up its defence exports and aims to reach \$5 billion by 2025 (Yadav, 2024). The next-generation technologies turning things perfect would include AI cybersecurity or blockchain, which would add to efficiency

and security measures. Ensuring long-term resilience and competitiveness in global markets must include a strengthening of private sector engagement and research and development.

6.2 Recommendations

Strengthening Domestic Semiconductor Manufacturing: India should enhance investments in semiconductor fabrication facilities so as to cut down on the excessive dependence on global supply chains (Pinto, 2023). With semiconductor manufacturing units being established under the India Semiconductor Mission, it would be prudent to ensure a steady supply of key electronic components for defence applications, thus relieving the risks of global shortages and trade restrictions.

Expanding Public-Private Partnerships in Defense Technology: The increased collaboration between DRDO, private companies, and international defence firms will enhance research, innovations, and production capabilities (Das, 2024). The government should reward private companies with an incentive to develop cutting-edge technologies like UAVs, AI-based defence systems, and electronic warfare solutions, thus providing an impetus for building a more self-reliant defence ecosystem.

Enhancing Supply Chain Resilience Through Digitalization: India should use blockchain and AI-based predictive analytics to enhance supply chain transparency and efficiency (Modgil *et al.* 2022). Implementation of blockchain to track military equipment and components will reduce counterfeiting risks, while AI can assist in optimizing logistics so as to ensure the timely availability of critical defence supplies, thus increasing overall operational readiness.

6.3 Recommendation for government public sector companies

Modernizing Public Sector Defense Production: State owned defense enterprises like Hindustan Aeronautics Limited (HAL), Bharat Electronics Limited (BEL), and Bharat Dynamics Limited (BDL) should invest in modernization and modernization through investments in Industry 4.0 technologies, such as automation, IoT, and AI-driven manufacturing, which can enhance productivity, reduce dependency on imports, and keep the defense sector in India competitive internationally.

Boosting Indigenous R&D in Defense Technologies: Enhanced expenditures in R&D can be secured by facilitating collaborative partnerships with institutions like DRDO, IITs, and private startups in the defense public sector. Improve R&D in key critical areas including hypersonic weapons, stealth technology, and cybersecurity, so that foreign suppliers can be avoided and India's strategic autonomy can be fortified.

Enhancing Export Capabilities and Global Collaboration: The government ought to assist public sector defense companies in establishing a presence in the international defense market by facilitating cooperation with allied countries. Companies like HAL and BEL should be incentivized to enter joint ventures, licensing agreements, and technology-sharing collaborations with international entities to increase defense exports from India.

7. Conclusion

In the post-COVID era, the advent of global collaborations, a paradigm change in policy pronouncements, and rapid technological advancement have invoked a combination of transformations in the defence electronics sector in India. Disruption of global supply chains revealed weaknesses in the system, and India started fortifying self-reliance under initiatives such as Atmanirbhar Bharat and the India Semiconductor Mission. Strategic international

partnerships with countries like the US, Israel, and France have greatly enhanced India's defence manufacturing capabilities, thus preventing the country from becoming a hostage to foreign suppliers. Indigenous initiatives to build radar systems, semiconductor fabrication, and AI-based logistics have greatly enhanced supply chain resilience. Investment in emerging technologies such as 3D printing, blockchain technology, and cybersecurity to ensure efficacy and security in defence processes has been made. Nonetheless, expanding semiconductor production, Enhancing Export Capabilities and Global Collaboration of Indian PSU's, increasing the private sector's involvement, and digital transformation of defence logistics need to remain an agenda in the medium term. Enhanced public-private partnerships and R&D investments are key to India attaining long-term resilient supply chains and establishing itself as a global leader in the defence electronic manufacturing sphere.

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